

MAINTENANCE BEHAVIOR OF LESSER AND LAWRENCE'S GOLDFINCHES

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In conjunction with a study of reproductive behavior in Lesser and Lawrence's Goldfinches (*Spinus psaltria* and *S. lawrencei*) (Coutlee 1968), an investigation of maintenance behavior in the two species was undertaken. This included any patterns not directly related to reproductive activity (flocking, feeding, drinking, bathing, preening, and sunning). Some of these patterns are similar to those already described for the American Goldfinch (*S. tristis*) (Coutlee 1963). Others, flocking and feeding behavior for example, have a special significance in the Lesser and Lawrence's Goldfinches, which often occur sympatrically and occasionally flock together.

METHODS

Field observations were made during the spring and summer of 1964 and 1965, incidental to a detailed study of reproductive behavior. The study area is located about five miles east of Newhall, California, in Placerita Canyon (latitude 34°22'N, longitude, 118°27'W, elevation 1800 ft). This canyon differs from the surrounding chaparral-covered hills in that it contains a permanent stream bordered by oak woodland. The variety of habitats provided supports an abundance of animal life including breeding populations of Lesser and Lawrence's Goldfinches. Although field work took place at all times of day, it was usually confined to the morning hours, from 06:00 to 12:00. The birds were observed with 7 × 50 binoculars, and a blind was not used.

In addition to studies in the field, eight goldfinches (five *lawrencei* and three *psaltria*) were kept in captivity at the University of California at Los Angeles from August 1964 to January 1965 and eight birds (three *lawrencei* and five *psaltria*) from September 1965 to June 1966. Daily activity cycles were observed for six of these field-caught birds (three of each species) by monitoring their movements in an experimental cage in the laboratory. A standard Hendryx cage (50 × 25 × 25 cm) was lined with sheets of acetate to prevent the birds from perching on the walls or roof. It was equipped with perches which were modified microswitches in which the trigger was extended by inserting it into a notch at the end of a short piece of ¼" doweling. Glass feeders providing seed and water were attached to the outside of the cage, and the bird could reach them by alighting on one of the small perches just in front of each feeder. These perches were arranged so that the bird was required to stand with its body vertical or to lean slightly backward unless it reached into the feeders. This arrangement prevented continuous perching at these points when the

bird was not actually eating or drinking. In addition, two larger perches were available on which the birds could alight after flights about the cage. Each of these microswitch-perches operated a timer (Cramer Controls Corporation, Type 633S), a counter (Veeder-Root, Incorporated, Form No. 15074), and two channels of an Esterline-Angus Operation Recorder, Model AW, equipped with marking pens writing continuously on paper moving at 3 inches per hour. (In order to prevent sustained load on the counters, each was activated through a Heinemann ¼ second time-delay relay, AN 1-522, XB.) The activity of the bird at each perch was indicated as: (1) total number of alightings, (2) total time perched, (3) time of day at which activity occurred, and (4) duration of each perching period. For the purpose of simplification, the two larger perches were arranged in series so that they activated the same counter, timer, and channels of the recorder. Each bird was placed in the experimental cage for three to five days until accustomed to the apparatus, and readings were taken subsequently for five days.

In order to keep the photoperiod somewhat similar to the natural one, the light schedule in the laboratory was altered periodically to correspond with the outdoor period. This necessitated a change during the period of recording activity so that three of the birds were monitored during a 12L:12D schedule while the other three were in an 11L:13D schedule. This difference of about 10 per cent in day length gave variations in activity which were much less than the individual and species differences observed (note tables 1, 3, and 4) and were considered negligible in this study.

Forty birds of each species (20 males and 20 females) were used for obtaining bill measurements with vernier calipers reading to the nearest 0.1 mm. These birds were study skins from the Donald R. Dickey Collection at the University of California at Los Angeles.

RESULTS

FLOCKING

Throughout the nesting season, small flocks of four to six goldfinches are regularly seen at foraging areas or near water. These flocks are usually of only one species, and although there is some agonistic behavior, the social tendency of the birds allows fairly peaceful intraspecific group feeding. Where the water supply is limited, it is not uncommon for small groups of both *lawrencei* and *psaltria* to be drinking and bathing side by side at these neutral areas.

Although a few *psaltria* occur in Placerita

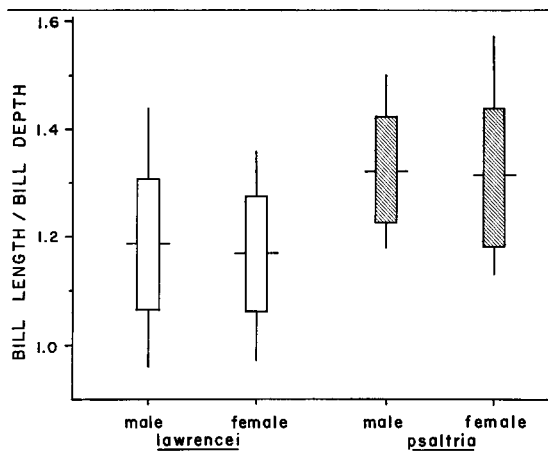


FIGURE 1. Ratio of bill length to bill depth. Vertical line = range; horizontal line = mean; vertical bar = two standard deviations on either side of the mean. Measurements of 20 adult males and 20 adult females of each species.

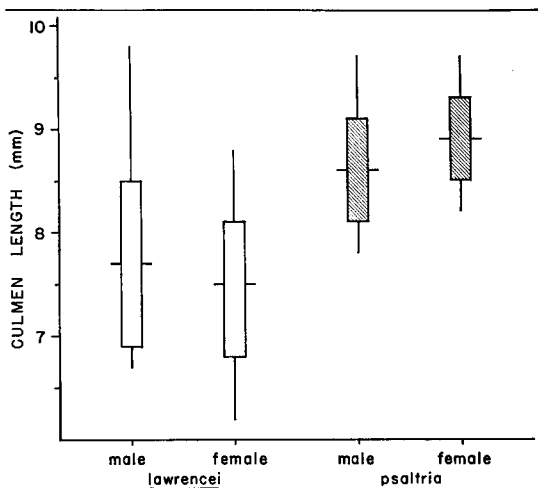


FIGURE 2. Culmen length (legend same as for fig. 1).

Canyon outside the breeding season, *lawrencei* are rare during the winter months. Just before and just after the summer reproductive season, however, the birds can be found in loose flocks of 20 to 30 individuals. The flocks may be composed of a single species or may include members of both species of goldfinches or even of other passerines (*e.g.*, House Finches [*Carpodacus mexicanus*] and Oregon Juncos [*Junco oreganus*]). In these flocks, *psaltria* (the smaller species) is dominant to *lawrencei* and displaces it from perches and food by aggressive displays or pecks.

Nineteen encounters were observed between captive adult *psaltria* and *lawrencei*. Of these, *psaltria* was the victor in 18. When the birds were deprived of food for one hour and then given seeds, *psaltria* always ate first, and *lawrencei* seldom even approached the food until the *psaltria* had left it. Field observations included six interspecific encounters in 1964. Of these, *lawrencei* was the victor only once. Juvenile *psaltria*, however, are not dominant to *lawrencei*. In captive birds, young *psaltria* usually adopted crouched postures or moved away from adult *lawrencei* when the latter approached. The *lawrencei* won 32 of 40 encounters observed between adult *lawrencei* and juvenile *psaltria*. The young *psaltria* probably avoid any larger birds, but by the time they are seven to eight months old, captive Lessers dominate adult Lawrence's. No encounters were observed between juvenile *psaltria* and *lawrencei*. In the one observed encounter between an adult *psaltria* and a juvenile *lawrencei*, the *psaltria*

won. On the whole, then, *psaltria* seems to be the dominant species even though it is smaller than *lawrencei*.

The large, mixed winter flocks tend to break up into flocks of 10 to 15 birds of a single species as the breeding season approaches. These in turn disintegrate as pairs are formed and territories are subsequently established.

FEEDING

Both Lesser and Lawrence's Goldfinches feed almost exclusively on seed-bearing chaparral plants, although a few insects (mostly Aphidae) may be taken during the breeding season. The major food sources of the two are similar. Linsdale's (1957) careful observation of food plants eaten by the two species indicates that, although the Lawrence's Goldfinch is much more restricted in its food (20 species of plants as compared with 55 in the Lesser Goldfinch), the seeds of about 70 per cent of these species are also eaten by the Lesser. As mentioned above, when members of the two species meet, *psaltria* is apparently dominant to *lawrencei* and usually displaces it from perches. Thus, direct competition probably occurs when the two utilize the same feeding areas simultaneously. Field observations of feeding behavior were inconclusive, but since birds of the two species were not seen feeding side by side it is assumed that some physiological or behavioral mechanism prevents this direct competition. The investigations of feeding patterns which follow may help to clarify this instance of partial niche overlap in closely related species.

Quantitative data on the amounts of seed obtained from each plant are lacking, but an

TABLE 1. Daily feeding activity of goldfinches in an experimental cage.
(Five days for each bird)

Individual	Hours of day-light	Time on food perch/day (min)						Average feeding time per day per gram body weight (min)	Number of times bird alighted on food perch/day					
		1	2	3	4	5	Mean		1	2	3	4	5	Mean
<i>lawrencei</i> ♂ (11.9 g)	12	51.3	54.7	49.5	58.7	66.7	56.18	4.72	749	613	493	613	409	575.4
<i>lawrencei</i> ♀ (13.3 g)	11	279.0	265.4	195.2	136.9	150.2	205.34	15.44	707	501	223	188	210	365.8
<i>lawrencei</i> juv. (10.9 g)	12	312.1	353.4	337.4	233.4	160.9	279.44	25.64	455	350	234	175	77	258.2
<i>psaltria</i> ♂ (10.45 g)	11	106.7	130.6	102.5	113.6	125.8	115.84	11.09	1419	1151	1232	1337	1339	1295.6
<i>psaltria</i> ♀ (9.15 g)	11	156.3	127.6	139.6	103.5	170.5	139.50	15.25	1895	2102	1944	2159	1942	2008.4
<i>psaltria</i> juv. (9.7 g)	12	361.1	174.1	151.1	152.2	208.8	209.46	21.59	161	113	129	129	207	147.8

indirect indication of possible food preferences can be obtained by measuring the size of the bill. Using the length of the culmen and the depth of the bill as representative of general bill size and shape, 40 birds of each species were measured (figs. 1 and 2). As can be seen by these figures, there was no significant difference between the sexes of a given species, as far as bill size is concerned. Although there is considerable interspecific overlap, it is evident that the bill of *psaltria* is significantly longer and more pointed than that of *lawrencei*, even though its body weight is about 8 per cent less. *Psaltria* thus may be able to handle larger seeds than *lawrencei*, and it can certainly extract them more easily from alder cones or clinging chaff. This probably contributes to the ability of *psaltria* to

take a wider variety of food plants than *lawrencei*.

The ratio of the length of the bill of *psaltria* to that of *lawrencei* is 1.13 : 1.00. According to Hutchinson (1959) this ratio should be at least 1.28 : 1.00 if the two species are to coexist without competition. In order to discover whether or not the two goldfinches could avoid competition by behavioral means, feeding patterns were monitored in the experimental cage described above (see Methods).

The daily feeding activity for three birds of each species (five days each) is summarized in table 1. As can be seen from this table, total feeding time is quite variable from one individual to another. In both species, however, the males consistently spent less time feeding than the females, and the juveniles fed more often than the adults per gram body weight. An hourly analysis of feeding activity (fig. 3) indicates that the two species are

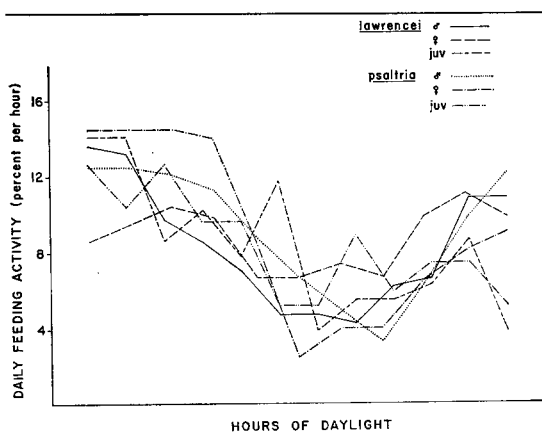


FIGURE 3. Feeding activity each hour plotted as a percentage of total feeding activity in the day. Each point indicates the mean of five days' observation. The horizontal axis represents 12 hours for adult male and juvenile *lawrencei*, and juvenile *psaltria*; 11 hours for adult female *lawrencei*, male and female *psaltria*.

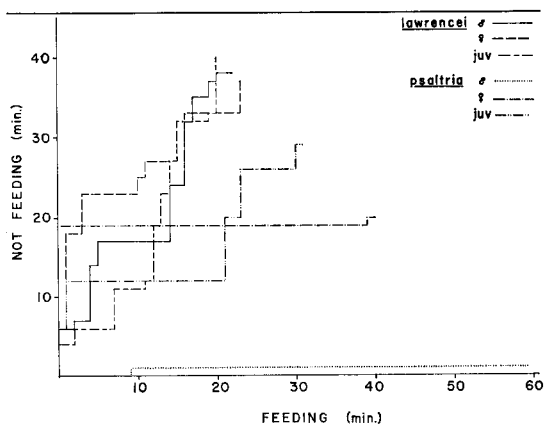


FIGURE 4. Cumulative ratio of feeding versus non-feeding time for the first hour of the day, last day of observation for each bird.

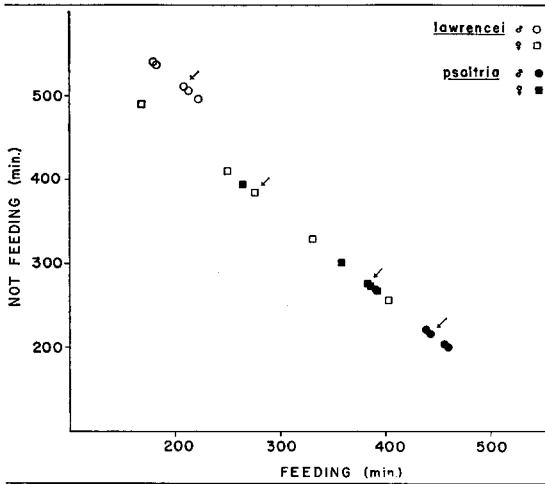


FIGURE 5. End points obtained from day-long curves of cumulative ratios of feeding versus non-feeding time in adult goldfinches (male *lawrencei*—12 daylight hours; female *lawrencei*, male and female *psaltria*—11 daylight hours). Arrows indicate median scores for each bird.

similar as far as general patterns are concerned.

When the data are broken down into one-minute intervals, however, a marked difference between the species is evident. A cumulative record of feeding activity was kept by designating each one-minute period as "feeding" or "not feeding," according to whether or not the bird perched at the food dish at any time during that period. This analysis resulted in graphs similar to the one in figure 4, showing the pattern for each of the six birds during one hour of peak feeding activity. The analysis was made for five full days for each bird. The end points for each curve thus obtained are shown for adults in figure 5. The patterns for the two juveniles showed extreme daily variation in both species. The feeding time for five days for *psaltria* ranged from 207 to 267 minutes, and that for *lawrencei* from 183 to 508 minutes. The feeding patterns were also quite variable and therefore much different from those of the adults. They will be omitted in the following discussion.

End-point comparisons between the sexes (one adult male and one adult female) and between the species are given in table 2. Although there is again some individual variation, it is obvious that, for these four birds, the two species are clearly different, while the two sexes are not. The Lesser Goldfinch fed for short periods alternated with short non-feeding periods. The Lawrence's Goldfinch, on the other hand, fed for longer periods, then perched for a time without feeding.

TABLE 2. Comparisons between species and sexes using the end-points of the cumulative feeding curves as indicators of feeding activity.
(Average of five days for each bird)

	<i>lawrencei</i>	<i>psaltria</i>	Mean
Male	201.6	437.6	319.6
Female	285.8	357.8	321.8
Mean	243.7	397.7	

DRINKING

Goldfinches as a group are highly dependent on a constant water supply and frequented the stream regularly throughout the period of study. Although Woods (1925) indicates that the Lawrence's Goldfinch seems to prefer quiet water and the Lesser running water, this did not seem to be the case in the birds I observed. There seemed to be no particular preference, and members of the two species sometimes flew to the stream together and drank side by side.

Data from the experimental cage are summarized in table 3. It will be noted that *psaltria* drinks considerably more often than *lawrencei* under laboratory conditions. Hourly analysis shows that this activity is fairly evenly distributed throughout the day in captive birds, rather than concentrated in the early morning and late afternoon as is feeding.

BATHING

Bathing is common in both species, and goldfinches were often seen at the stream edges bathing at any hour of the day. The birds entered shallow water to a depth of about 1 cm and bathed in the manner of other passerines (see, for example, Nice 1943), first dipping the head into the water, then lowering the breast, fluffing the contour feathers, fluttering the wings and tossing water up over the back, meanwhile spreading and lowering the tail. This often continued for as long as one or two minutes, until the bird was thoroughly wetted. It was always followed by flight to a perch and a subsequent period of shaking and preening.

PREENING

As in most birds, a large portion of each day was spent in preening. This behavior serves to clean and rearrange the feathers and is, in addition, a displacement activity during conflict situations. The preening movements of both *lawrencei* and *psaltria* are similar and like those of *tristis*, which have already been described in detail (Coutlee 1963).

TABLE 3. Daily drinking activity of goldfinches in an experimental cage.
(Five days for each bird)

Individual	Hours of day-light	Time on water perch/day (min)						Average drinking time per day per gram body weight (min)	Number of times bird alighted on water perch/day					
		1	2	3	4	5	Mean		1	2	3	4	5	Mean
<i>lawrencei</i> ♂ (11.9 g)	12	3.1	2.3	3.7	2.2	2.7	2.80	0.24	110	139	126	38	43	91.2
<i>lawrencei</i> ♀ (13.3 g)	11	0.9	0.8	0.9	1.0	1.0	0.92	0.07	33	33	39	20	27	30.4
<i>lawrencei</i> juv. (10.9 g)	12	1.4	1.6	1.8	1.0	1.2	1.40	0.13	41	95	31	20	23	42.0
<i>psaltria</i> ♂ (10.45 g)	11	19.7	12.9	17.1	22.4	26.7	19.76	1.89	1423	1135	1149	1214	829	1150.0
<i>psaltria</i> ♀ (9.15 g)	11	1.2	1.5	1.8	1.8	1.5	1.56	0.17	33	41	48	78	84	56.8
<i>psaltria</i> juv. (9.7 g)	12	17.6	8.0	18.1	15.4	11.9	14.20	1.46	121	54	88	108	125	99.2

SUNNING

Sunning was observed in both Lesser and Lawrence's Goldfinches and lasted in one case for 20 minutes. The birds perch facing the sun but may orient their heads at right angles to the incident rays. The contour feathers were markedly fluffed in the Lawrence's Goldfinches observed sunning, but this was not seen in the Lesser.

During early morning songs and quiet morning perching, male Lesser Goldfinches usually faced the rising sun, perhaps assisting in elevating body temperature on waking. In addition, this orientation served to emphasize the bright yellow breast of the breeding males and certainly made them more conspicuous to human observers. Perhaps this behavior also reestablishes territorial ownership early each day. No particular orientation toward the sun was noted in afternoon or evening perching of males on their territories.

Among the male Lawrence's Goldfinches there also seemed to be some tendency to face the sun while singing. Their habit of perching within dense clumps of leaves, however, made it difficult to see them. Linsdale (1950) mentions that *lawrencei* males at the Hastings Natural History Reservation often faced the sun when they sang.

DAILY ACTIVITY

Although field observations indicated a typical trend of general activity with peaks in early morning and late afternoon, quantitative measures of activity were confined to the laboratory. The experimental cage allowed recording activity (other than feeding and drinking) as the number of times the bird alighted on the main perches. Individual vari-

ations in the daily pattern are shown in figure 6 where hourly averages for five days for each bird are plotted. Total activity on the main perches is summarized in table 4. These data verify the field observations of activity periods and also indicate that individual variation is greater than variation due to sex, age, or species.

DISCUSSION

The sympatric association of two morphologically and behaviorally similar species makes studies of their behavior patterns especially intriguing. The goldfinches under consideration here show variation not only in reproductive behavior but also in maintenance activities. In addition, their habit of associating together in flocks during the nonreproductive season results in some degree of direct competition for food.

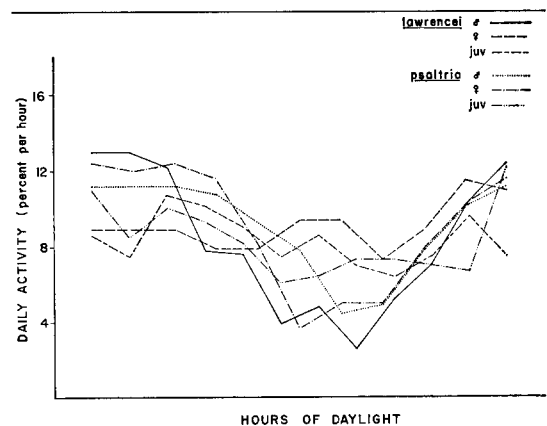


FIGURE 6. General activity each hour plotted as a per cent of total activity during the day (legend same as for fig. 3).

TABLE 4. Daily activity of goldfinches in an experimental cage.
(Five days for each bird)

Individual	Hours of day-light	Time on main perches/day (min)						Average resting time per day per gram body weight (min)	Number of times bird alighted on main perches/day					
		1	2	3	4	5	Mean		1	2	3	4	5	Mean
<i>lawrencei</i> ♂ (11.9 g)	12	576.0	558.1	589.1	573.6	539.7	567.30	47.67	5825	6029	8518	8235	5700	6861.4
<i>lawrencei</i> ♀ (13.3 g)	11	273.8	360.4	362.2	372.3	358.7	345.48	25.98	5022	4717	5518	2553	2567	4075.4
<i>lawrencei</i> juv. (10.9 g)	12	539.0	312.1	335.2	362.5	421.5	394.06	36.15	3456	3761	4293	3332	2020	3372.4
<i>psaltria</i> ♂ (10.45 g)	11	210.3	253.5	256.1	291.0	313.1	264.80	25.34	6728	4964	5164	5084	5893	5566.6
<i>psaltria</i> ♀ (9.15 g)	11	455.0	468.4	418.6	364.3	450.2	431.30	47.14	11461	13975	13180	13794	9846	12451.2
<i>psaltria</i> juv. (9.7 g)	12	420.3	461.1	517.5	518.4	468.5	477.16	49.20	2110	2266	2453	2671	2758	2451.6

FLOCKING

Since goldfinches as a group are highly social, the presence of intra- and interspecific flocks, especially outside the breeding season, is not surprising. It is of interest, however, that the smaller *psaltria* appears to be dominant over *lawrencei*. This situation also seems to occur in the congeneric blackbirds which breed sympatrically in California (Orians and Collier 1963). In these species, the smaller Red-winged Blackbird (*Agelaius phoeniceus*) is dominant over the Tricolored Blackbird (*A. tricolor*) if two individuals meet. When in the presence of Red-wings, the Tricolors ordinarily are successful in occupying and maintaining breeding areas only because they occur in large, closely knit flocks. Competition for food is avoided since the birds utilize separate feeding areas. Goldfinches, on the other hand, seem to utilize similar feeding areas and probably rely on behavioral differences to avoid direct competition.

FEEDING

The Lesser and Lawrence's Goldfinches both depend upon plants found in the chaparral for food, and many of the same plants are taken by both species. Since the bill of *psaltria* is more tapered than that of *lawrencei*, it might be used more effectively to extract seeds from chaff or alder cones and to manipulate a wider range of seed sizes. The ratio of the culmen length of *psaltria* to that of *lawrencei*, however, is only 1.13:1.00, suggesting a similarity in food preference. As pointed out by Schoener (1965), this ratio is usually small in sympatric congeners whose food source is abundant. They must depend, then, on other means of partitioning the avail-

able food supply if competition is to be avoided. The two sympatric goldfinches studied illustrate different patterns of feeding. Captive *lawrencei* showed long continuous periods of feeding alternated with periods of quiet perching during peak feeding periods. Conversely, *psaltria* were constantly active during the feeding periods, flying back and forth repeatedly from the food source to other perches. If this behavior also occurs in wild birds, it would suggest that *lawrencei* spends time searching out rich food sources where it can remain feeding for several minutes while *psaltria* flies about gleaning seeds from isolated stalks. This behavior would allow *psaltria* to feed in areas not frequented by *lawrencei* and to harvest seeds more thoroughly in those areas already visited by *lawrencei*. Unfortunately, laboratory studies of feeding behavior occurred late in the study, and quantitative field observations of searching behavior were not obtained. It may be noted, however, that *lawrencei* and *psaltria* were not seen feeding together, and selectivity of food sources certainly cannot be overlooked. If it does occur, the two species could live in the same area, eat the same foods, and still avoid competition by precisely selecting their feeding areas. On the other hand, food supply may be restricted by competition and may act as a limiting factor to population size in one or both species.

DRINKING

Both goldfinches require free water and are found in nature only where a constant water supply is available. In an experimental situation, the Lesser Goldfinch drank much more often and for longer periods at a time than

did the Lawrence's. In both species, drinking activity occurred regularly throughout the day, both in the field and in the laboratory.

SUNNING

Sunning occurs in many birds, and goldfinches are no exception. In the *psaltria* male, however, this behavior may be associated with territory-holding. The males often perch conspicuously in sunny areas in the tops of trees, especially in the morning. Thus, in addition to elevating body temperature, the bright yellow coloring of the body is made conspicuous. The territory-holder may, therefore, advertise his ownership by this prominence early in the day.

OTHER MAINTENANCE BEHAVIOR

The general patterns of maintenance behavior (including preening and bathing) are apparently extremely stable characters and are indistinguishable from those of other fringilids. The highly active early-morning hours, midday rest period, and second late-afternoon peak in activity are typical. Both species of goldfinches show a similar pattern of activity.

SUMMARY

A field and laboratory study of maintenance behavior was carried out from 1964 to 1966, incidental to a study of breeding biology of Lesser and Lawrence's Goldfinches. The two species are highly social and often occur together in flocks, especially outside the breeding season. Laboratory observations show that *psaltria* is dominant over *lawrencei* and displaces it from food and perches.

Both species utilize many of the same plants for food in the wild. Studies in the laboratory show that although feeding activity occurs at the same time of day in both, their feeding behavior differs. *Psaltria* tends to fly about actively during feeding periods and perch intermittently at the food source, while *lawrencei* exhibits comparatively long periods of feeding alternated with periods of quiet perching. The implications of these findings for wild birds are discussed.

Patterns of drinking, bathing, preening, and sunning are described and briefly discussed. Daily activity cycles are similar to those of other passerines, with morning and evening peaks and midday lows.

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